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Journal of the Society of Arts.

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FRIDAY, AUGUST 7, 1868.

Announcements by the Council.

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Council Meeting.

July 27th.

Lord Henry Gordon Lennox, M.P., was unanimously elected Chairman of the Council for the ensuing year.

Prizes.

The Council, at the suggestion of the Food Committee, offer the following prizes for Improved Railway Meat Vans, Milk Vans, and Milk Cans :—

1. For an improved method of conveying meat by rail, the Society's *Silver Medal* and £10.

The object in view is to reduce to a minimum the deterioration which meat now suffers in its transit by rail. The principal evils to be avoided are—excessive changes of temperature, and injuries by pressure, by handling, exposure to dust, insects, &c. This prize may be awarded for an improved railway meat van or for a travelling meat larder suitable for railways.

Model on a scale of half an inch to a foot to be sent in.

2. For an improved method of conveying milk cans by by rail, the Society's *Silver Medal* and £10.

The object in view is to reduce to a minimum the deterioration which milk now suffers in its transit by rail in the ordinary open trucks. The principal evils to be avoided are—the heating and shaking of the milk cans.

Model of an improved railway milk van, on a scale of half an inch to the foot, to be sent in.

3. For an improved railway milk can, the Society's *Silver Medal* and £10.

The object in view is to reduce to a minimum the deterioration which milk now suffers in its transit by rail in the ordinary milk cans, or "churns." The principal evils to be avoided are—the heating of the milk, and all motion within the can which may cause the buttery particles to separate.

Harvesting Corn in Wet Weather.

The Essay by Mr. W. A. Gibbs, of Gillwell-park, Sewardstone, Essex, for which the Gold Medal of the Society and a prize of Fifty Guineas were awarded, is now ready. Published by Messrs. Bell and Daldy, York-street, Covent-garden, publishers to the Society of Arts; price one shilling, illustrated by woodcuts.

Subscriptions.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial Officer.

Proceedings of the Society.

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Cantor Lectures.

"On Food." By Dr. Letheby, M.A., M.B., &c.

Lecture II., delivered Monday, January 27.

Comparative Digestibility of Foods—Functions of Different Foods.

(*Continued from page* 657.)

Functions of Fat.—The hydrocarbons which go by the name of fat, differ from other hydrocarbons, as sugar and starch, in the circumstance that the oxygen is never in sufficient quantity to satisfy the affinity of the hydrogen; and, therefore, fat is more energetic as a respiratory or heat-producing agent. Its power, indeed, in this respect, is just twice and a-half as great as that of starch or sugar; for 10 grains of it will, by combining with oxygen, develop sufficient heat to raise 23·21bs. of water one degree of Fahrenheit; and according to the deductions of both Joule and Meyer, this is equivalent to the power of raising 17,923lbs. one foot high. In cold countries, where animal warmth is required, food rich in fat is always preferred; and the fat bacon of the English labourer contributes in no small degree to the production of mechanical force.

But besides this, fat serves important functions in the processes of digestion, assimilation, and nutrition. According to Lehmann, it is one of the most active agents in the metamorphosis of animal matter; and this is seen not merely in the solution of nitrogenous articles of food during digestion, but also in the conversion of nutrient plastic substances into cells and masses of fibre. Elsässer long since observed that during the process of artificial digestion, the solution of nitrogenous foods was considerably accelerated by means of fat; and Lehmann has since determined, by actual experiment on dogs, that albuminous substances deprived of fat remain longer in the stomach, and require more time for their metamorphosis than the same substances impregnated with fat. It is probable, indeed, that the digestive power of the pancreatic fluid is due in great measure to the presence of fat; and that the subsequent chymification of food, and its absorption into the blood, is greatly assisted by it. There is also good reason for believing that it is largely concerned in the formation of bile, and that the biliary acids are conjugated fatty compounds. This may account for the well-known action of fat bacon, and other such foods in promoting the secretion of bile.

The digestive power of fat is certainly considerable; and it is no less active in the subsequent conversion of nitrogenous matters into cells and tissues, and perhaps also in effecting their retrograde decay. Colourless blood corpuscles receive perhaps the first impulse of their formation from the metamorphosis of fat; and thus it may be an important aid in the genesis of blood. It would appear, too, from the latest investigations of physiologists that it plays an equally important part in every kind of cell development. Acherson showed, as far back as 1840, that albumen always coagulates from its solution around a fat globule, and this is seen in the little fatty particles of milk, which have a covering like a cell-wall of consolidated casein. Hunefield, Nasse, and others, have further shown that the nucleoli of cells invariably consist of fat, and that recently-formed plasma always contains more fat than the mature cell. The conclusion, therefore, is that it takes an active part in all the processes by which the nutrient constituents of food are converted into the solid substrata of organs; and so energetic are its powers in this respect, that when the nitrogenous matters of the fluids are not in sufficient quantity to form cells with the fat, it borrows the material from muscular or other tissues, and thus produces a fatty degeneration of the part. This is observed in the muscular structures of over-fed animals, in the tissues of drunkards, who take a large amount of fat-forming food, and in the livers of geese that are crammed with a farinaceous diet.

And not only is it concerned in the formation of new tissue, but it also pervades, and finally disintegrates, the older structures, especially when the vitality of them is low. In this manner it helps in the solution and subsequent removal from the animal body of decayed and morbid products of the protein type.

Again, its presence in large quantity in the tubules of nerves, and in the ganglionic centres, would indicate that it performs some highly important functions in nervous action.

And lastly, the distribution of it in the tissues, and the accumulation of it around certain organs, serve to fill up the vacuities of the body, to give rotundity to the form, to equalize external pressure, to diminish the friction of parts, to give suppleness to the tissues, and by its bad conducting property to retain the animal warmth. Fat, therefore, must always enter largely into the composition of our food, for other hydrocarbons, though capable of transformation into fat, cannot entirely take its place.

3rd. *Starches and saccharine substances.*—These are well called hydrates of carbon, for the oxygen and hydrogen contained in them are nearly always in the proportion to form water. The carbon, therefore, is alone capable of oxydation, and according to Liebig their functions are entirely calorific or respiratory; but, like other heat-producing agents, they must also have mechanical power, for everything that will raise the temperature of a pound of water one degree of Fahrenheit will, by another modification of its action, raise 772lbs. a foot high. The energies, however, of this class of substances are not nearly so great as with fats, for in the last case, as I have said, there is much available hydrogen, as well as carbon, for oxydation. The diagram which is before you will make this clear.

Calorific and Motive Powers of 10 Grains of the Substance in its Natural State.

	Lbs. of water raised 1° Fahr.	Lbs. lifted one foot high.
Grape sugar	8·4	6,477
Lump sugar	8·6	6,617
Arrowroot	10·0	7,731
Butter	18·6	14,358
Beef-fat	20·9	16,131

So that, in round numbers, the calorific power of fat is about twice as great as that of starch and sugar, and when dry it is twice and a-half as great.

But these substances have other duties to perform besides the development of animal heat, which is, in fact, the final product of their oxydation, for on becoming changed into glucose by digestion they take the form of various acid compounds, as lactic acid, which occurs in the stomach and in the juice of flesh; butyric, formic, and acetic acids, which are found in the perspiration. The exact functions of these acids are not known to us, although, as I have already explained, the presence of lactic acid in the stomach is essential to the digestion of nitrogenous matters; and perhaps also its occurrence in the juice of flesh is for a similar object—namely, the solution of effete tissues.

Starches and sugars are also concerned in the production of fat. This was once the subject of an animated discussion by Liebig and Dumas, whose views of it were in complete antagonism; but the experiments of Boussingault, Persoz, Lawes, and others, on the feeding of animals have proved beyond all question that fat may be derived from the hydrates of carbon, and that therefore the views of Liebig were correct. Common experience, indeed, has fully taught us that foods which are rich in farinaceous matters and sugar are very capable of producing fat.

4th. The *saline* or *mineral* constituents of food are largely concerned in the metamorphosis of matter; and, perhaps, this is their sole function. It is a specialty of these substances to give a soluble form to the plastic constituents of food, and of the animal tissues. They are, therefore, concerned in the phenomena of digestion, absorption, sanguification, assimilation, disintegration, and secretion. In truth they are the chief, if not the only, media for the transference of organic matter from place to place in the animal body—being on one hand the purveyors of nutrient materials into the system, and on the other the carriers of effete substances out of it; besides which, it is very probable that they are the agents whereby liquid colloidal forms of nutriment are changed into solid or pectous, as in the formation of solid tissues from the blood. In the case of digestion and absorption the plastic elements of our food, as albumen, fibrin, gelatin, &c., are not of themselves capable of dialysis, or of passing through the walls of the alimentary canal; and, therefore, absorption must be assisted by some physical agent. This agent is the highly diffusive acids and salts which are secreted so freely into the stomach during digestion; and it is very probable that they not only effect a solution of the proteinaceous matter of food, but, by converting it into peptones, as Lehmann expresses it, they also change the molecular form of the material, and make it pass from an unabsorbable colloid into a highly diffusive crystalloid. If, indeed, it be, as Mr. Graham supposes, that a colloid molecule is but a group of smaller crystalloids, the action of the saline and acid constituents of the gastric juice might be to break up the larger colloid molecule, and thus give it the property of diffusion and absorption. An opposite condition of things would occur in the alkaline blood, whereby the colloid molecule would regain its structure, and lose its diffusive tendency; but, coming to the tissues, where an acid condition of the fluids again exists, it once more changes its molecular structure, and quits the blood to serve the purposes of nutrition. The exact nature of the phenomena that occur when the liquid nutrient matter which thus escapes is changed into solid tissue is unknown to us; but there is good reason for believing that it is no more than a molecular movement effected by the agency of saline matter. In the case of certain structures which contain more than a common amount of mineral salts, this is unquestionably so, for it occurs in the consolidation of the spiculæ of sponges, the calcareous tissues of polypes, the hard dermal structures of the radiata, mollusca, crustacea, &c., and in the calcareous deposits of bone, teeth, tegumentary scales, egg-shells, &c., of the vertebrata. In all these instances the secreted matter must first have been crystalloidal, or it could not have been secreted; it then takes the form of a liquid colloid or jelly; and finally, by a further molecular movement, it passes into the condition of a pectous solid—the saline constituents, according to their nature and proportion, determining the degrees of hardness.

Again, the removal of effete matters and worn-out tissues is undoubtedly effected by the agency of saline substances; for, during the processes of oxydation, acid compounds are produced, which, by acting chemically on the saline constituents of the animal fluids, give them a solutive power on plastic matters, and thus enable them to remove the debris of worn-out tissue.

As to special functions of the several saline constituents of food, little can be said; but it is a remarkable fact that the *alkaline or basic phosphate of soda* is invariably found in the blood, while *acid phosphate of potash* is the chief constituent of the juice of flesh. Most likely the former is concerned in preserving the liquid colloidal condition of albumen and fibrin, and so keeping them from being lost by secretion, while the latter is engaged in an opposite duty. The alkalinity of the blood also helps in the oxydation of organic matters; and as the basic phosphate of soda is endowed, like an alkaline carbonate, with the power of absorbing carbonic acid, it is the chief agent whereby this compound is removed from the system. This is a remarkable property, and is one of the chief uses of basic phosphate of soda in the blood. In point of fact, when it is not there in sufficient quantity to perform this function, it is replaced by an alkaline carbonate. We find this to be so in the blood of herbivorous animals, where the proportions of the two salts are the reverse of what they are in man and carnivora. Some notion may be formed of the relative importance of the saline matters of the blood by reference to this diagram from Liebig.

PERCENTAGE COMPOSITION OF THE MINERAL MATTERS OF BLOOD.

	Man.	Pig.	Dog.	Fowl.	Sheep.	Ox.
Phosphoric Acid	31·79	36·50	36·82	47·26	14·80	14·04
Alkalies	65·66	49·80	55·24	48·41	55·79	60·00
Alkaline Earths	3·33	3·80	2·07	2·22	4·87	3·64
Mineral Acids and Oxide of Iron......................	9·22	9·90	5·87	2·11	24·54	22·32
Total	100·00	100·00	100·00	100·00	100·00	100·00

And in those cases where the phosphoric acid is deficient, it is replaced by carbonic acid. In man, for example, the quantity of combined carbonic acid in the ashes of the blood is only 3·78 per cent., whereas in the calf it is 9·85, and in the sheep 19·47 per cent., so that in all cases the alkalinity of the blood remains the same.

The *salts of potash* in the juice of flesh have, no doubt, an equally important duty to perform, although of an opposite character; for while the alkaline phosphate of soda in the blood prevents the transudation of nutrient matter, the acid phosphate of potash in the muscular fluid promotes it; and thus it is concerned in nutrition and in the solution of worn-out tissues.

Earthy phosphates, especially *phosphate of lime*, are, perhaps, the agents for the consolidation of tissue; for not only are they present in the hard structures of the body, as the bones and teeth, but they also enter into the composition of flesh.

And not less important in the morphological functions of the animal body is the presence of *common salt*. It is a large constituent of every one of the secretions, and forms about half the total weight of the saline matters of the blood. Unlike the phosphates, however, it does not enter into the composition of tissue, but seems to be only a medium of absorption and secretion; and so necessary is it for this purpose, that it is not possible to alter, to any large extent, its proportion in the blood. If we drink water containing but little common salt in solution, it does not permanently dilute the blood, but passes off immediately by the kidneys; and if we try to increase the amount in the blood by drinking solutions of salt, as sea water, it refuses to be absorbed. This normal proportion of it in the blood is evidently a physiological necessity, which the conditions for diffusion imperatively demand. It is a curious fact, also, that common salt has the faculty of forming crystallizable compounds with most of the unorganised and effete constituents of the body. May it not, therefore, be an important agent of diffusion, and be thus concerned in the phenomena of absorption and secretion; for as colloidal matters—albumen and fibrin—cannot pass through the walls of the intestines, or the blood-vessels, it may well be that through the agency of common salt and the free acid of the gastric and muscular juices, they temporarily assume a crystalloidal condition, and are thus absorbed or secreted.

The constant presence of common salt in the secretions, and the necessity for it in due proportion in the blood, indicate the importance of a proper supply of it with the food. We perceive this in the instinct of animals, and in our own craving for it when it does not exist in sufficient quantity in the food. Animals, in fact, will travel long distances, and brave the greatest dangers, to obtain it. Men will barter gold for it; indeed, among the Gallas, and on the coast of Sierra Leone, brothers will sell their sisters, husbands their wives, and parents their children, for salt. In the district of Accra, on the Gold Coast of Africa, a handful of salt is the most valuable thing upon earth after gold, and will purchase a slave or two. Mungo Park tells us that with the Mandingoes and Bambaras the use of salt is such a luxury, that to say of a man "he flavours his food with salt" is to imply that he is rich; and children will suck a piece of rock-salt as if it were sugar.

The experiments of Boussingault have shown that, although salt mixed with the fodder of animals does not much affect the quantity of flesh, fat, or milk obtained from them, yet it seriously affects their appearance and general condition; for animals deprived of salt, other than that contained naturally in the food, soon get heavy and dull in their temperament, and have a rough and staring coat. Reulin states that animals which do not find it in their food or drink, become less prolific, and the breed rapidly diminishes in number. This is confirmed by Dr. Le Saine, who says, in his prize-essay on salt, that it increases the fertility of the male and the fecundity of the female, and it doubles the power of nourishing the fœtus. During the period of suckling, also, salt given to the mother renders the milk more abundant and more nutritious. It likewise accelerates growth, and gives a finer condition to the skin; and the flesh of animals fed with it is better flavoured, and more easily digested, than that of animals which do not partake of it. In barbarous times, the most horrible of punishments, entailing certain death, was the feeding of culprits on food without salt; and in the experiments of the French Academicians, flesh deprived of its saline constituents by being washed with water, lost its nutritive power, and animals fed on it soon died of starvation. Even after a few days, with such a diet, the instincts of the animals told them it was worthless as food; indeed, for all purposes of nutrition, it was, as Liebig says, no better than the eating of stones, and the utmost torments of hunger were hardly sufficient to induce them to continue the diet. There was plenty of nitrogenous matter in the food, but there was no medium for its solution and absorption, and hence it was useless.

The *oxides of iron*, and their homologues, the *oxides of manganese*, are largely concerned in the processes of sanguification and oxydation. They enter into the composition of the globules of the blood—manganese being the chief mineral constituent of the corpuscles of white-blooded animals, and iron of red. In fact, the colouring-matter of the blood discs (cruorin), as well as that of the muscles (myochrome), is a compound of iron and albumen (globulin), which has a remarkable property of absorbing oxygen when exposed to the air, and of giving it out again in the presence of reducing agents. In the one case it acquires an arterial tint, and in the other a venous; and the spectrum informs us that these two conditions of it are easily assumed—one by the presence of atmospheric oxygen, and the other by decaying organic matter. It is hardly to be doubted that these are the conditions of it in blood—the bright red oxydized cruorin being the form of it in arterial blood, and the dark reduced variety of it in venous. The functions, therefore, of both cruorin and myochrome are entirely of a respiratory nature; for, in the former case it is the medium whereby oxygen is absorbed from the air in the lungs, and is carried with the blood-discs throughout the body, and in the latter it may be the agent of interstitial oxydation.

Lastly, there is a mineral constituent of our food, *silica*, which enters into the composition of all the tegumentary appendages. Its presence is not of so much importance to us as to the lower animals, whose warmth is retained by a natural covering of hair, or wool, or feathers. In the case of birds, indeed, the quantity of silica in the feathers is very considerable, and Gorup-Besanez has described its physiological relations.

As to the proportions of mineral substances required in the food, it is difficult to speak. Dr. Edward Smith says that an adult man requires daily from 32 to 79 grains of phosphoric acid; from 51 to 175 grains of chlorine (equal to from 85 to 291 grains of common salt); from 27 to 107 grains of potash; from 80 to 171 of soda; from 2·3 to 6·3 of lime; and from 2·5 to 3 of magnesia. According to Mr. Lawes, a very small portion of these salts is retained in the system; for in fattening pigs he found that of every 11 lbs. of mineral matter contained in the food only twelve ounces were stored up in the body, and this was chiefly the earthy phosphates, all the rest being either unabsorbed, or else used in the work of absorption, assimilation, and secretion. In most cases, therefore, there is sufficient saline matter, excepting common salt, in all ordinary food; but for all this, the presence of it in the water we drink is not an unimportant question. Four-fifths of the earth's surface are composed of calcareous strata, which yield water that is more or less rich in carbonate and sulphate of lime; and it may well be that this is a wise provision for the supply of these salts to the animal system. As Mr. Johnston has truly observed in his "Chemistry of Common Life," "The bright sparkling hard waters which gush out in frequent springs from our chalk and other lime-stone rocks are relished to drink, not merely because they are grateful to the eye, but because there is something exhilarating in the excess of carbonic acid they contain and give off as they pass through the warm mouth and throat; and because the lime they hold in solution removes acid matters from the stomach, and thus acts as a grateful medicine to the system. To abandon the use of such a water, and to drink daily in its stead one entirely free from mineral matter, so far from improving the health, may injure it;" in fact the water of a country may determine the diet of its inhabitants. The soft waters of the lakes of Scotland, for example, may have had something to do with the choice of brown meal; and but for the calcareous waters of Ireland the potato could not have become a national food.

And now, before I leave this part of the subject, it is right that I should say a few words respecting the functions of certain beverages (as *tea*, *coffee*, and *fermented liquors*), which have been more or less in use in all ages, as if from an untaught physiological instinct. Vegetable infusions, containing the same active principles—namely, astringent matter, volatile oil, and a crystallizable body rich in nitrogen, have been resorted to for some undefined purpose by the natives of every climate; indeed, to use the words of Mr. Johnston, "the practice has prevailed equally in tropical and in arctic regions. In Central America, the Indian of native blood, and the Creole of mixed European race, indulge alike in their ancient chocolate. In Southern America the tea of Paraguay is an almost universal beverage. The native North American tribes have their Apallachian tea, their Oswega tea, their Labrador tea, and many others. From Florida to Georgia in the United States, and over all the West India Islands, the naturalised European races sip their favourite coffee; while over the Northern States of the Union, and in the British provinces, the tea of China is in daily and constant use.

"All Europe, too, has chosen its prevailing beverage; Spain and Italy delight in chocolate; France and Germany, and Sweden and Turkey, in coffee; Russia, Holland, and England, in tea—whilst poor Ireland makes its warm drink of the husks of the cocoa, the refuse of the chocolate-mills of Italy and Spain.

"All Asia feels the same want, and in different ways has long gratified it. Coffee, indigenous in Arabia or the adjoining countries, has followed the banner of the Prophet, wherever in Asia or Africa his false faith has triumphed. Tea, a native of China, has spread spontaneously over the hill country of the Himalayas, the table lands of Tartary and Thibet, and the plains of Siberia; has climbed the Altais, overspread all Russia, and is equally despotic in Moscow as in St. Petersburg. In Sumatra, the coffee-leaf yields the favourite tea of the dark-skinned population; while Central Africa boasts of the Abyssinian chaat as the indigenous warm drink of its Ethiopian people. Everywhere, in fact, unintoxicating and non-narcotic beverages are in general use among tribes of every colour, beneath every sun, and in every condition of life. The custom, therefore, must meet some universal want of our nature, some physiological function which science has not yet explained; and, considering that these beverages contain essentially the same chemical compounds, it is remarkable that they should have been selected from the whole range of the vegetable kingdom." As Mr. Johnston truly observes, "What constitutional cravings common to us all have prompted to such singularly uniform results! Through how vast an amount of unrecorded individual experiences must these results have been arrived at!"

The principal constituents of these vegetable substances are:—

1st. A *volatile oil*, on which their aroma depends, and which rarely amounts to one part in 150. 2nd. An *astringent acid*, of the nature of *tannic acid* in tea, and called *caffeic acid* in coffee, which give them their bitter styptic taste; it amounts to from 13 to 18 per cent. in tea, and to about 5 per cent. in coffee; and 3rd. A crystallised nitrogenous substance of an alkaline nature called *Theine* or *Caffeine*, and *Theobromine*. The average amounts of this alkaloid in different vegetable substances, according to Dr. Stenhouse, is here recorded:—

	Theine or Caffeine per cent.
Guarana or Brazilian cocoa, from *Guarana officinalis*	5·07
Good black tea	2·13
Black tea from Kemaon, E. I.	1·97
Dried coffee leaves	1·26
Maté or Paraguay tea from *Ilex Paraguayensis*	1·20
Various samples of coffee-beans from 0·8 to	1·00

The physiological properties of this substance, and of its homologue, theobromine, are not clearly discoverable. Mulder states that they are not the agents concerned in the peculiar action of tea and coffee. Liebig, however, points to the fact that with the addition of oxygen and the elements of water, they can yield taurine, which is the nitrogenised constituent of bile; and he asks whether they may not be concerned in the production of bile. Theine, he also states, is related to kreatinine—that remarkable compound, produced in the vital process, and occurring in the muscular system of animals; and to glycocol, which we may suppose to exist in gelatine coupled with another compound. In fact, according to him, there are no drinks which in their complexity and in the nature of certain constituents, have more resemblance to soup than tea or coffee; and it is very probable, he says, that the use of them as a part of food depends on the exciting and vivifying action which they have in common with soup. Reasoning in this way it may be said that theine or caffeine, and theobromine are closely related in their composition to nervous tissue, and that therefore they are suited for the repair and renovation of the exhausted brain. Experiments made by Lehmann, in 1854, with infusion of roasted coffee, and with caffeine, went to show that their chief influence on the human body was to retard the waste of tissues; that when, for example, an infusion of three-quarters of an ounce of roasted coffee was taken daily for a fortnight, the amount of urea and phosphoric acid excreted by the kidneys was less by one-third than when the same food was taken without the coffee. The empyreumatic oil was found to exert a stimulating action on the nervous system, and when taken in excess caused excitement and wakefulness. It also operated on the skin by producing a gentle perspiration, and it removed the sensation of hunger. The conclusion from these experiments was, that both tea and coffee exhilarate the nervous system, and, by lessening waste, enable the food to go further in its nutritive action; that with a given quantity of food, more work could be performed when these beverages were taken than otherwise; and that in old, infirm persons, where the desire for tea is so strong, the waste and decay of the system was lessened. It operates, in fact, as a sort of lubricant of the animal system, and by oiling the machinery, enables it to work easier and longer.

The more recent experiments of Dr. Edward Smith are not exactly to the same purpose; for, in his opinion, tea promotes rather than checks the chemico-vital functions of the body, for directly after it is taken, the quantity of carbonic acid emitted from the lungs, and the quantity of air inspired are increased; and there is greater depth and freedom of respiration. In this way, he thinks it promotes the transformation of starchy and fatty food; besides which, it increases the action of the skin, and by inducing perspiration lessens the heat of the body. Coffee, he says, has an opposite effect, for it lessens the action of the skin, and promotes that of the bowels; and its influence on the respiratory processes is somewhat less than that of tea.

It is manifest from all this, that we have yet to learn what are the special actions of these beverages; and why it is that they have been used in all times, and in all countries, as a means of supplying some natural want which science is unable to discover—that everywhere, the poor and the needy, the aged and the infirm, will make a sacrifice of even nutritious food for some such beverage as tea and coffee—that not less than 500 millions of the human race should make use of an infusion of tea; that more than 100 millions should drink coffee; about 50 millions cocoa; and not less than 10 millions of the inhabitants of Peru, Paraguay, and the Brazils, should use an infusion of maté or guarana. In this country alone there is over 100 millions of pounds of tea consumed annually, and perhaps, about half as much of coffee. All this looks like the influence of some deep-seated necessity, which our philosophy is unable to fathom.

And with regard to the use of *fermented liquors*, there is the same universal indication of their serving a profound physiological purpose, and supplying a common want. It is no argument that, because these things have been abused they serve no purpose in man's economy. On the contrary, the fact of their use in all time, and that no saccharine liquid, or juice of ripe fruit, can be exposed to the air without spontaneous and almost immediate fermentation, are striking evidences of a useful purpose. They may not enter into the composition of tissues, but they may stimulate the energies of the living frame, and rouse them into increased activity. It is not merely the brick-work and marble, so to speak, of the human body, nor yet the concrete movements of the machine, that have to be sustained, for there are rarer forms of matter, and higher manifestations of force, concerned in man's existence; and his resort to such beverages as these may be for something more than the nourishment of the system, or even the mere raising of his spirit above the common concerns of this work-o-day world.

That *alcohol* stimulates the action of the nervous system there is no doubt, and it is equally certain that it increases the respiratory changes. Dr. Edward Smith is of opinion that it also lessens the action of the muscles which are subject to volition, and increases, in a certain degree, the action of those which are independent of it, as the heart and respiratory muscles. He finds, too, that it diminishes the functions of the skin, and by thus lessening the waste of animal heat, it has a conservative tendency. The effects of alcohol are, however, much modified by the substances with which it is associated in different alcoholic liquids—*beers* and *ale*, for example, act on the respiratory functions by reason of the saccharine and nitrogenous matters they contain; *wine* also, as well as *cider* and *perry*, have a similar action, and in proportion to their saccharine and acid constituents; *brandy* and *gin* lessen the respiratory changes, and the latter acts on the kidneys by reason of the volatile oil it contains; *whiskey* is uncertain in its effect on the lungs; while *rum*, like *beer* and *ale*, is a true restorative, as it sustains and increases the vital powers; and he says that the old fashioned combination of *rum* and *milk* is the most powerful restorative with which he is acquainted.

Leibig is of opinion that alcohol is burnt or oxydised in the system, and is therefore a calorific agent; but the researches of Lallemand, Perrin, and Duray, as well as those of Dr. Edward Smith, have demonstrated that a large portion of it passes through the system unchanged, and appears in the breath and perspiration, as well as in the urine. They, therefore, conclude that alcohol is not a food, but is a mere excitor of the nervous centres. On the other hand, Dr. Thudicum, in a rather large experiment on the students of his class (33 in number), found that of the 4,000 grammes of alcohol in the 44 bottles of wine which they drank at one sitting, only 10 grammes appeared in the urine; and assuming that about 10 grammes more were exhaled by the breath and skin, he concluded that only 0·5 per cent. of the alcohol escaped unchanged. He therefore believes that alcohol is oxydised in the body, and is a true food.

But besides this, the inquiries of Poiseuille have shown that it is a physical as well as a chemical and physiological agent, for it hinders the flow of liquids in narrow tubes, and may act in the same way on the movements of the blood in the capillary vessels. He found, for example, that when the flow of a certain quantity of water through a small tube occupied 575·8 minutes, and of the serum of blood 1048·5 minutes, the flow of the same quantity of Madeira wine under the same circumstances was 1138 minutes, of sparkling Sillery 1463, and of Jamaica rum 1832. Its functions, therefore, are manifestly of a complicated nature; in fact the whole subject is remarkably obscure, and requires the light of science to illuminate it. As in the case of tea and its allies, ages of empiricism are waiting for a philosophical interpretation.

Lastly, as to the functions of *condiments*, as *peppers*, *mustard*, *spices*, &c. They are merely stimulants of the digestive organs, promoting the flow of the saliva, the gastric juice, and other intestinal secretions; and increasing the peristaltic movements of the viscera. They thus aid in the processes of digestion; and by giving flavour to the food, they whet the appetite, and so increase the relish for it—indifferent food is thus made palatable, and its digestion accelerated.

And now, in conclusion, we may safely inquire, as a supplementary question to the functions of food, what are the mechanical and thermotic powers, as well as the fattening capabilities of various articles of diet?

Dr. Frankland has made some very careful determinations of the calorific values of different substances used as food; and remembering that every pound of water raised one degree of Fahrenheit represents a mechanical force of 772 lbs. lifted a foot high, it is easy to calculate the working energy of any substance from its thermotic power when burnt in oxygen, or when less perfectly consumed in the animal body. Arranging the results under these two heads, we shall find that the energies of different articles of diet may be expressed as in the table at top of next page.

It will be understood, of course, that to obtain these results in the animal body the materials must be completely absorbed, and fully oxydised into carbonic acid, urea, &c.

Estimated in this manner it may be said that a daily subsistence diet of two ounces of dry nitrogenous food, and 13·2 ounces of dry carbonaceous, calculated as starch; and a daily working diet of six ounces of dry nitrogenous matter, and twenty-six ounces of dry carbonaceous, have the following mechanical energies:—

	Lbs. lifted one foot high.	
	When burnt in oxygen.	When oxydised in the body.
Subsistence diet..........	6,319,783	6,307,078
Working diet............	13,349,405	13,311,290

But the actual working power of the human body does not approach this. In fact, although a man's daily labour has a very large range, as from 300,000 foot-pounds when lifting dung into a cart to 1,500,000 foot-pounds when pushing or pulling horizontally; yet, the average is not above one million foot-pounds, as will be seen from this diagram:—

Actual Energy of Ten Grains of the Material, in its Natural Condition, when completely Burnt in Oxygen, and when Oxydised into Carbonic Acid, Water, and Urea, in the Animal Body.

	Per cent. of water in Material.	Lbs. lifted one foot high.	
		When burnt in Oxygen.	When Oxydised in the body.
Butter	15	14357	14357
Cheshire cheese	24	9187	8613
Oatmeal	15	7913	7769
Wheat flour	15	7788	7591
Pea-meal	15	7778	7456
Arrowroot	18	7731	7731
Ground rice	13	7535	7424
Yolk of egg	47	6761	6532
Lump sugar	19	6616	6616
Grape sugar	20	6476	6476
Entire egg	62	4708	4507
Bread crumb	44	4409	4246
Ham	54	3915	3317
Mackerel	71	3537	3187
Lean beef	71	3098	2818
Lean veal	71	2594	2314
Guiness's stout	88	2123	2123
Potatoes	73	2002	1969
Whiting	80	1787	1563
Bass's ale	88	1530	1530
White of egg	86	1325	1138
Milk	87	1306	1241
Carrots	86	1040	1026
Cabbage	89	858	830

Kind of labour.	Amount of work in foot-pounds.	Authority.
Bricklayer's labourer carrying bricks	1,627,200	Mayhew.
Coal whipping	1,293,600	"
Ascending Faulhorn	1,074,931	Wislicenus.
Do. do.	933,746	Fick.
Treadmill	1,008,000	Mayhew.
Do.	861,156	Ed. Smith.
Turning a winch	837,760	Coulomb.
Pedestrians (20 miles a day)	792,000	Haughton.
Paving and pile-driving	788,480	Coulomb.
Porters carrying loads	732,480	"
Shot-drill punishment	694,400	Haughton.
Average	967,614	

And even when we add the calculated internal work of a man's body, as the beating of the heart and the movements of respiration, the total of it does not much exceed a million and a-half foot-pounds a-day.

	Foot-pounds.
External work or actual labour	967,614
Work of circulation (75 beats a minute)	497,880
Work of respiration (15 a minute)	98,064
Total ascertainable work per day	1,563,558

It is evident, therefore, that a large portion of our food must escape digestion and absorption; indeed, the thermotic power of the food actually consumed daily, as estimated by the carbonic acid exhaled and the urea secreted, is not more than sufficient to raise the temperature of 10,000 lbs. of water one degree of Fahrenheit. This is equal to a force of 7,720,000 lbs. lifted a foot high; so that the ascertainable work of the food is about one-fifth of its actual energy, the rest of the power being consumed in molecular movements within the animal body. Helmholtz asserts that the external work should be a fifth part of the mechanical force of the digested food; but labour must be well applied to develop this proportion of its energy.

In the steam-engine, according to Sir William Armstrong, only a tenth part of the actual power of the fuel is realised as work. The human machine is therefore more economical of its force than a steam-engine; in fact it is assumed by Heidenham and others that not less than half of the force applied to the living muscles, as it is developed in their tissue, is ultilized. But although the animal machine is so much more economical of force than the steam-engine, yet on account of the costliness of its fuel, &c., it is far more expensive. Taking, for example, a steam-engine of one-horse power (that is, a power of raising 33,000 lbs. a foot high per minute), it will require two horses in reality to do the same work for ten hours a day, or twenty-four men; and the cost would be 10d. for the steam-engine, 8s. 4d. for the two horses, and just £2 sterling for the twenty-four men.

Dr. Frankland has estimated the weight and cost of various articles of food required to be oxydised in the animal body in order to raise 140 lbs. (a rather small man) to the height of 10,000 feet, supposing that only one-fifth of the actual energy of the food is manifested as external work. Here is a part of his table:—

	Ounces required.	Cost.	
		s.	d.
Oatmeal	20·5	0	3½
Flour	21·0	0	3¾
Pea-meal	21·4	0	4½
Bread	37·5	0	4¾
Potatoes	81·1	0	5¼
Rice	21·5	0	5½
Beef-fat or dripping	8·9	0	5½
Cheshire cheese	18·5	0	11½
Cabbage	192·3	1	0¼
Butter	11·1	1	0½
Hard-boiled eggs	35·3	1	2½
Lump sugar	24·1	1	3
Milk	128·3	1	3½
Lean beef	56·5	3	6½
Guiness's stout	6¾ bottles.	5	7½
Bass's pale ale	9 do.	7	6

The motive power of fatty foods is thus shown to be far higher than that of lean meat or farinaceous substances, and this accords with experience, for the labouring classes have long since discovered that fat bacon is a good material for heavy work. Its efficacy may, in great part, depend on the ease and certainty with which it is digested and utilised in the body.

The *fattening functions* of food are liable to great variation, not merely from the quality of the food itself, but from the peculiarity of the individual consuming it. This is a matter of common observation, and is well known to the breeders of stock. Messrs. Lawes and Gilbert found in their experiments on the feeding of bullocks, sheep, and pigs, that very different quantities of food were required to produce the same increase of weight. Oxen and sheep, for example, feeding on the same diet, namely, oil-cake, hay, and turnips, consume, in one case (that of oxen), 1,109 lbs. of dry substance for every 100 lbs. of increase in the live weight, while in the other, the sheep consume only 912 lbs.; and pigs fed on barley-meal will fatten to the same extent on 420 lbs. of the dry material. Pigs, therefore, store up about one-fourth of their food, reckoned in this way; sheep about one-ninth, and oxen only one-eleventh.

The proportions of the several constituents of the food are also very differently used by these animals; for in every 100 parts of the dry food eaten, the several amounts of nitrogenous, carbonaceous, and mineral matters are thus disposed of:—

CONSTITUENTS OF THE DRY FOOD.		Proportions in dry food.	Proportions stored in animal.	Proportions in manure.	Proportions lost in respiration.
Oxen	Nitrogenous......	19·66	0·8	29·1	57·3
	Carbonaceous	72·86	5·2		
	Mineral..........	7·48	0·2	7·4	—
		100·00	6·2	36·5	57·3
Sheep	Nitrogenous......	19·41	0·8	25·1	60·1
	Carbonaceous	73·57	7·0		
	Mineral..........	7·02	0·2	6·8	—
		100·00	8·0	31·9	60·1
Pigs	Nitrogenous......	12·38	1·7	14·3	65·7
	Carbonaceous	85·00	15·7		
	Mineral..........	2·62	0·2	2·4	—
		100·00	17·6	16·7	65·7

So that the power of appropriation is greatest with pigs and least with oxen; in fact, of every 100 lbs. of the several constituents of the food, the following are the proportions stored up in the three classes of animals:—

	Pigs.	Sheep.	Oxen.
Of 100 Nitrogenous	13·5	4·2	4·1
Of 100 Carbonaceous	18·5	9·4	7·2
Of 100 Mineral	7·3	3·1	1·9

It will be noticed, too, that the proportions lost in respiration are very different in the three cases; for it is greatest in the pig—amounting to nearly 66 per cent. of all the food eaten, and least in the ox, 57·3 per cent. These proportions represent the vital work of the body during the processes of growth and repair.

The time also that is occupied in producing fat and muscular tissue is different with these animals, for the pig increases from 6 to 6·5 per cent. of its weight per week; the sheep not more than 1·75 per cent.; and the ox only 1 per cent. Some of this difference is, doubtless, due to the quality of the food made use of, for the pigs were fed on a nutritious and easily digestible diet—oat-meat; while the sheep and oxen made use of food with a large quantity of cellular tissue and woody fibre; and here, I may remark, that the power of utilising the inferior varieties of food is very different with different classes of animals. Man, as I have already explained, is unable to digest woody fibre, or even the harder kinds of cellulose; it is doubtful indeed whether he can digest cellulose at all. The pig also has but a limited capacity for this kind of work; whereas oxen and sheep, and the herbivora generally, can eat woody tissues with advantage, and convert them into flesh and fat. In eating meat, therefore, we are utilising the digestive powers of other animals; and are, in fact, employing their stomachs to do for us that which we could not do for ourselves. This, as Mr. Lawes says, is proved, not merely by the testimony of common experience, but also by certain anatomical facts relating to the structure and comparative size of the stomach in different animals. In oxen, for example, the stomach weighs 51 ounces for every 100 lbs. of live weight; in sheep it weighs 39 ounces; in pigs 14 ounces; and in man only 6 ounces. It is manifest, therefore, that the food of man should be more concentrated than that of the lower animal; and that he acts wisely in eating flesh and fat, which are the very essence of food, for he thereby economises labour, and employs the assimilative powers of other creatures to bring the crudest materials into a nutritious and highly digestible form. It is true that man, in common with other animals, is able to convert starch and sugar into fat, and the lower qualities of albumen into flesh, but by so doing he expends force, for in the case of fat he locks up in it twice and a-half the potential energy of sugar and starch.

Looking broadly, therefore, at the functions of food, and regarding the animal body as a machine, in which potential energy is rendered active, it would appear that its main duty is to develop force by the oxydation of carbo-hydrogens contained in the blood, and not by the oxydation of tissue. A portion of tissue no doubt decays in the transference of its energies to other forms of action, and requires repair; but the decay is scarcely more rapid at one time than another, and is in no case, when sufficient food is supplied, the cause of mechanical labour. "In man," say Dr. Frankland, "the chief materials for muscular power are non-nitrogenous; but nitrogenous matter can also be employed for the same purpose, and hence the greatly increased evolution of nitrogen under the influence of a flesh diet, even with no increase of muscular exertion. The non-nitrogenous matters, also, which find their way into the blood, yield up all their *potential* energy as *actual* energy; whereas the nitrogenous in leaving the body as urea carry with them a portion (at least one-seventh) of their potential energy unexpended. The transference of potential energy into muscular power is necessarily accompanied by the production of heat within the body, even when the muscular power is exerted externally. This is, doubtless, the chief, and probably the only source of animal heat."

Proceedings of Institutions.

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EXAMINATION PAPERS, 1868.

(Continued from page 659.)

The following are the Examination Papers set in the various subjects at the Final Examination held in April last:—

NAVIGATION AND NAUTICAL ASTRONOMY.

THREE HOURS ALLOWED.

Section I.

1. Define a great and a small circle on the surface of a sphere. Investigate the relation between the circumference of a small circle and that of the large circle parallel to it.

2. Show that in any spherical triangle the sum of the three angles is greater than two and less than six right-angles; and that the difference between the sum of any two angles and the third is less than two right-angles.

3. Obtain an expression for the cosine of the angle of a spherical triangle in terms of the sides.

Section II.

1. State Napier's rules for the solution of a right-angled spherical triangle, and prove them in the case where the complement of one of the angles is the middle part.

2. Given two sides and the included angle of a spherical triangle, find the third side in a form adapted to logarithmic calculation.

3. What is meant by the spherical excess; obtain an

expression for the area of a spherical triangle, and find it when the three sides are given.

Section III.

1. Find the compass course and distance from A to B. Given—

Lat. A 37° 18′ N. Var. 2 pts. W. Long. A 39° 18′ E.
„ B 37° 18′ N. Dev. 10° 30′ E. „ B 48° 33′ E.

2. Find the compass course and distance from A to B. Given—

Lat. A 44° 53′ S. Var. 1½ pts. E. Long. A 97° 18′ W.
„ B 78° 16′ S. Dev. 8° 35′ W. „ B 121° 44′ W.

3. On June 25th, at noon, a point of land in latitude 18° 13′ N., long. 133° 25′ W. bore by compass N.N.E distant 18 miles. Ship's head E., deviation 10° 40′ E., variation 1 point W. Afterwards sailed by compass as follows during the next twenty-four hours:—

K.	1/10	Courses.	Wind.	Leeway.	Deviation.
57	5	E. b. N.	W.N.W.	1½	3° 20′ E.
41	6	S.S.E.	N.W.b.N.	1	0° 56′ W.
48	9	S.W. b. W.	E.S.E.	2	8° 34′ W.
65	7	N.E. b. E.	S.E.	1¾	10° 50′ E.

A current set the ship during the last four hours S.W. by compass 2½ miles an hour. Required the latitude and longitude on June 26th at noon.

Section IV.

1. Define the terms *course, distance, departure,* and *rhumb-line;* and show by a diagram how *departure* is measured. Obtain equations connecting (1), *course, distance, and departure,* (2), *course, distance,* and *diff. lat.* (3), *course, diff. lat.* and *dep.*

2. Write down and prove the formula employed in Mercator's sailing. How could you construct a Mercator's chart?

3. Obtain an expression for the distance in sailing on a great circle from one point to another.

Find the distance from A to B.

Lat. A 12° 18′ S. Long. A 18° 23′ W.
„ B 33° 25′ N. „ B 44° 15′ W.

Section V.

1. On June 10, 1868, the observed mer. alt of Sirius (zenith N. of star) was 32° 18′ 25″. Index cor. — 3′ 40″ height of the eye above the sea 21 feet. Required the latitude.

2. On July 2, 1868, in long. 54° 25′ W. the observed mer. alt., moon's upper limb, was 54° 18′ 30″ (zenith S. of moon). Index cor. + 5′ 35″. Height of the eye, 24 feet. Required the latitude.

3. June 1, 1868, at 8h. 20m. a.m., in lat. 18° 20′ S., long. 100° 40′ W. the obs. alt. sun's L.L. was 22° 42′ 20″, when the sun bore by compass, N. 67° 18′ E. (Ship's head being W., dev. 11° 35′ W.) Index cor. — 4′ 5″, and the height of the eye 17 feet. Required the variation of the compass.

Section VI.

1. Define the terms *right ascension, declination, latitude,* and *longitude* of a heavenly body; *amplitude* and *azimuth.*

Show how to find the latitude of the observer by the observed meridian altitude of a heavenly body; the zenith being north of the body and the declination being south.

2. Prove the rule for finding the variation of the compass by the observed amplitude of the sun.

3. Prove the rule for finding the latitude by two observed altitudes of different heavenly bodies at the same time.

Section VII.

1. Jan. 15, 1868, at 6h. 15m. a.m., in lat. 60° 15′ S. long. 110° 10′ W. the obs. alt. Sun's L.L. was 18° 38′ 50″. Index cor. + 3′ 10″, height of the eye 18 feet, when the chronometer showed 1h. 32m. 30s. Required the longitude.

On Jan. 1, at noon, the chronometer was slow on Greenwich mean time 2m. 3s. ·4, and losing 8·5s. daily.

2. Sept. 1, 1868, in lat. 49° 10′ N. long. 31° 10′ W. the following observations were taken:—

	Obs. alt. α Arietis.	Obs. alt: moon's L.L.	Obs. dist. F.L.
	43° 43′ 50″	30° 36′ 30″	58° 23′ 10″
Index cor.	+ 1′ 10″	— 1′ 35″	— 1′ 45″

and the height of the eye was 15 feet. Required the longitude.

Section VIII.

1. Describe the sextant, and prove the rule by which it is graduated.

2. To what errors of adjustment is the sextant liable? Show how they may be remedied.

PRINCIPLES OF MECHANICS.

THREE HOURS ALLOWED.

1. What cases of equilibrium in forces acting on a particle are evidently true?

2. State the proposition commonly called the parallelogram of forces. Assuming its truth for the direction of the resultant, prove it for the magnitude.

Example.—Two forces acting on a particle are inclined to each other at an angle of 30°, one force being equal to four pounds, and the other to six; find the magnitude of their resultant.

3. Enunciate the experimental laws of friction considered (1) statically, (2) dynamically.

Example 1.—A copper cubical box, half full of water, is placed on an oak table, which is slowly tilted up; determine whether it will slide or topple over. (Coefficient of friction=·62.)

Example 2.—If a plane whose inclination to the horizon is 30°, be so rough as just to support a body, find the least force that will drag the body up it, the weight being supposed equal to a ton.

4. Investigate the condition of equilibrium of two forces acting in any direction at the extremities of a lever.

Example.—A lever 12 feet long will balance at two feet from one end, but when a weight of 50lbs. is hung from the other end it balances at two feet from that end; find the weight of the beam.

5. Define the centre of gravity of a body. Show how to find from elementary principles the centre of gravity of any regular figures which you may select.

Example.—A triangle has 3, 4, 5 for its sides; find the distance of the centre of gravity from each side.

6. State the laws of motion. How does Attwood's machine experimentally prove them?

7. Prove that if a body be urged by a constant and uniform force, the space which it describes from the beginning of the motion is equal to half the product of the force and the square of the time.

Example.—Two weights of 97 and 96 lbs. hang over a fixed pulley; find the space descended by the heavier weight in 8 seconds.

Example.—A stone, thrown at an angle of elevation of 45° from the top of a tower, fell in four seconds at a distance of 60 feet from the base; find the height of the tower.

9. Explain the phrase "Modulus of a Machine."

Example.—The diameter of the piston of an engine is 80 inches, the mean pressure of the steam is 12 lbs. per square inch, the length of the stroke is 10 feet, the number of strokes is 11 per minute. How many cubic feet of water will it raise per minute from a depth of 250 fathoms, its modulus being ·6?

10. What is meant by impulsive action? What is the fundamental principle in the solution of problems upon this action? If two inelastic bodies impinge, prove the formula for their common motion after impact.

Example.—A sphere weighing 2lbs., and moving with a velocity of 20 feet per second, meets another weighing 5lbs., and moving with a velocity of 5 feet per second. Determine their common velocity after impact.

11. Define the terms "radius of gyration," "moment of inertia."

Example.—Find the moment of inertia of a sphere revolving around a diameter.

12. Define *vis viva*, and state upon what its utilty depends. Investigate the motion of a ball inside a cylinder rolling on a horizontal plane.

13. Describe any recently invented instruments for measuring and registering the pressure of the wind. Explain clearly in what way the wind turns the sails of a windmill, and describe the best form and proportion of the sails.

(*To be continued.*)

OPENING OF THE THAMES EMBANKMENT FOOTWAY.

The Thames Embankment has become a reality, and on Thursday, the 30th July, and from that day henceforth, Londoners will be able practically to appreciate the advantages of what is declared, not altogether without reason, to be the finest metropolitan thoroughfare in the world. Months, indeed, will yet elapse before the Thames Embankment will be open to vehicles, but persons on foot can now avail themselves of it, and the flow of passengers that set in the moment the barriers were thrown down sufficiently proved that the new thoroughfare will not be neglected by the public. Of opening ceremonial there was nothing, or next to nothing; indeed, the authorities consider the admittance of pedestrians to the embankment as indicating nothing but a stage towards the completion of the work, and they were not disposed to raise the event into undue importance. At half-past eleven o'clock a body of some two or three hundred invited visitors assembled at the north pier of Westminster-bridge, and there awaited the arrival of Lord John Manners, the Right Hon. W. Cowper, Sir J. Thwaites, Mr. Tite, M.P., Lord Ebury, the Marquis Townshend, the Lord Mayor, Alderman Salomons, M.P., Alderman Lawrence, M.P., Colonel Hogg, M.P., Mr. Powell, M.P., and other gentlemen interested, personally or officially, in the undertaking. A sort of straggling procession was then formed, the visitors walking along the embankment, and stopping here and there to admire the strength and the solidity of the embankment, the various piers, the lions' heads, the bends and turns of the line of masonry, and whatever else caught their eye. The day was hot, and a blazing sun bathed the white stonework in a painful glare of light; and the visitors were unanimous in the opinion that no time should be lost in planting trees along the river side, for the purpose of affording shelter from the rays of the summer sun. Apart from this drawback there was cause for nothing but congratulation at the noble undertaking that is now so near its completion. It is every way a work worthy of a great nation, and will endure as a lasting monument of the commerce, the wealth, and the public spirit of the first capital of the world. People who think it a sign of superior wisdom to go into raptures over the Haussmannisation of Paris may be recommended to pay a visit to this undertaking, the like of which no city on the Continent can show. It would be a long story were we to dwell upon the engineering difficulties that have been overcome; and, besides, engineering difficulties in this age seem to be only made to be overcome. But it is worth observing that the Thames Embankment, and in connection with it the metropolitan main drainage works—two of the most gigantic civic undertakings ever undertaken—have been accomplished at a cost that is comparatively moderate in itself, and that has certainly pressed with no very serious weight on the inhabitants of London. The memories of men are short in this high-pressured age, and a nuisance is no sooner removed than it is straightway forgotten. But we may be allowed to remind ungrateful Londoners that the Thames, which is already a healthful, and may soon be a pleasant and silver stream, was, not many years ago, the fertile source of fever and cholera, and every summer the cry went forth—"What is to be done with it? How shall we purify it?" That problem has been solved. The river has been cleansed. A promenade along its banks is an agreeable summer excursion. Members of Parliament, on these hot July evenings, have clustered by the score on their river terrace, and Londoners generally will soon discover that the Thames Embankment is, or may be made, by providing trees, seats, &c., the coolest and most agreeable thoroughfare in London. But this could never have been felt, and the embankment itself could never have been constructed, if the ancient foulness of the river had remained. As it is, the breath of Father Thames is pure and sweet, and his votaries inhale it with pleasure. His waters are not altogether so limpid and clear as they might be; but we live in hope of better days even in that respect. The ugliness of this our "city of exigency" is so generally taken for granted, that one feels some diffidence in saying that the scene on the river yesterday had points of comeliness and beauty about it. But even at the risk of being accused of enthusiasm, we will venture to observe that, in spite of the "severe simplicity" of the opening ceremonial, there was something in the general aspect presented from the river side upon which the eye could linger with pleasure. That vast heap of buildings, that enormous congregation of tower and dome, and spire and chimney, as it spreads before you is in itself a sight that would strike eyes unaccustomed to it; and in the clear morning air of yesterday the picture was presented with unusual distinctness. The tide was high, the traffic on the river but little, so that the whole stretch of the embankment masonry was visible at a glance, in the full beauty of its bold sweeps and graceful outline. We predict that when the embankment is completed it will be not only an airy and convenient, but also a very picturesque thoroughfare.

The idea of embanking the Thames is no modern one. The names of Sir Frederick Trench and Mr. Martin, the painter, stand prominently forward amongst the earliest promoters of a general embankment of the Thames through the metropolis, the former having upwards of 40 years since suggested an embankment, with a roadway upon it, extending on the Middlesex shore between London and Westminster bridges, the latter having prepared a similar plan combining with his design a scheme for the interception of the sewage from the river. Subsequently, in 1840, Mr. James Walker prepared a plan for the Corporation, followed by Mr. Page and others at various subsequent dates. The line laid down by Mr. Walker, which differs but slightly from that of other promoters, has been approved and recommended by various Parliamentary committees and Royal commissions, until at length it received the sanction of Parliament. The frontage line to which a solid embankment should be carried out was fixed, and handed over in the form of an act to the Metropolitan Board of Works in 1862. The line of, and scheme for, the embankment of the south side of the Thames originated with the Metropolitan Board of Works, and an act for its construction was obtained in 1863. The designs for the Thames embankments, as now constructed, both on the north and south sides of the river, are entirely original, having been prepared for the board by their engineer, and approved and adopted by them. Those for the north side were completed, the contracts let, and the works commenced in February, 1864. The works for the south side were commenced in September, 1865. The northern embankment, which extends between Westminster and Blackfriars bridges is let in three contracts, the aggregate length being 6,640 feet, and the cost of the works, as tendered for, £875,500. The southern embankment extends from Westminster-bridge up the river towards Vauxhall-bridge, and a portion of the works consists in widening and a part in narrowing the river. The total cost of this contract is £309,000, the length of the roadway from Westminster-bridge to Vauxhall being 5,000 feet, and its width 60 feet. The footway from

Westminster to Lambeth-bridge in front of St. Thomas's Hospital was opened to the public in May last, and has been very much used by them since that date. The paved footway next the river, from Westminster-bridge to the Temple on the northern embankment, is 20 feet wide, with approaches to Villiers-street, Wellington-street, and Essex-street, Strand. The roadway will be 100 feet wide, including both footpaths, but it is not to be formed until after the Metropolitan District Railway Company shall have completed their railway, which will for a considerable length pass under the new roadway. The embankment road will be continued by a new street which is about to be formed from Blackfriars-bridge to the Mansion-house. About 37 acres of land have been reclaimed from the mud banks of the river by the embankment, and will be laid out in approaches, ornamental grounds and gardens, as soon as the railway works have sufficiently advanced to admit of the execution of such works. It is expected that the embankment and railway will be completed within a year from the present time. The engineer observes that causes of delay have hitherto arisen to which it may be unnecessary more particularly now to refer, but which the Metropolitan Board of Works have been unable to control. These have considerably retarded the progress of the work, but it is hoped that they have now all been surmounted, and that the works yet to be constructed will progress vigorously and satisfactorily.

When the visitors had finished their perambulations over the embankment, some guns were, upon a signal from Sir John Thwaites, fired, by way of informing the public that henceforth and for ever the thoroughfare is open to them, and the party of guests then proceeded, in two steamboats, down the river to North Woolwich, and thence by rail to Barking, to inspect the new Abbey Mills Pumping Station. As these works are extremely curious, a brief description of them will not be uninteresting. A prominent feature of the design for the main drainage of London is the attempt which has been made, as far as possible, to remove the sewage by gravitation, and thus to reduce the pumping to a minimum. It is, however, impossible for sewage to fall by gravitation for a distance of ten or twelve miles from districts which are lower than, or near the level of, the river, and yet at their outfall to be delivered at the level of high water without the aid of pumping. Thus it happens that all the sewage on the south side of the Thames, and the sewage of a portion of the north side, has to be lifted, and for this purpose there are four pumping stations, two on each side of the river. Of those on the south side, one is situate at Deptford Creek, of 500 nominal horse-power, and the other at the Crossness outfall, also of 500 nominal horse-power; the latter was opened by the Prince of Wales in April, 1865. Of those on the north side, the largest and most important is the Abbey Mills Station near to Bow, in the north-east district of London, which was viewed and in full operation yesterday. It is of 1,140 nominal horse-power. The fourth will be the smallest station, being of 240 nominal horse-power only, and situated at Pimlico. Its work is at present performed by a temporary engine. The permanent station awaits the formation of that part of the low level sewer which is to be constructed under the Chelsea Thames Embankment, the Act for which has just received the Royal assent. The Abbey Mills pumps lift the sewage of Acton, Hammersmith, Fulham, Shepherd's Bush, Kensington, Brompton, Pimlico, Westminster, the City, Whitechapel, Stepney, Mile-end, Wapping, Limehouse, Bow, and Poplar, representing an area of 25 square miles, a height of 36 feet from the low level to the high level sewers, whence it will flow on by the side of the high level gravitating sewers to the northern or Barking outfall, and thus it is there are no pumps at the northern as at the southern outfall. This station covers an area of seven acres, divided into two portions by the northern outfall sewer, which passes diagonally across it on an embankment raised about seventeen feet above the surface. A chance visitor to Barking—if chance visitors can ever be supposed to find their way to that singularly uninviting neighbourhood—would be astonished at finding that that smart but queer-looking building—something between an orphan school and a reformatory—was the Abbey Mills sewage pumping station. It is built in the form of a cross. The external parts are highly decorated, coloured bricks. encaustic tiles, stone dressings, and carved work being freely used. The engine-house and boiler-houses form one building, the former being, as we have said, in the shape of a cross, and the latter forming two wings to the north-eastern arm of the cross. The extreme dimensions of the building, taken across two of the arms, is 142 feet 6 inches, the width of each arm being 47 feet 6 inches. Each of the two boiler-houses measures 100 feet in length by 62 feet in width; and there is a workshop situate between the two, measuring 49 feet 6 inches by 33 feet. The engine-house consists of four storeys in height, two of which are below and two above the surface of the ground; the height of the two lower storeys being 38 feet and that of the two above ground, measured from the engine-room floor to the apex of the roof, being 62 feet. In the centre, or intersection of the four arms of the cross, the building is covered by a cupola of an ornamental character, rising to a height of 110 feet from the engine-room floor. The chimney shafts, of which there are two, one on each side of the engine-house, are 209 feet in height and eight feet internal diameter throughout. They correspond in style with the main building, and are similarly enriched with coloured bricks and stone dressings, and are capped at the top by an ornamental cast-iron roof, pierced with openings for the egress of the smoke. The foundations of brickwork and concrete extend to a depth of 35 feet below the finished surface. The engines are eight in number, each of 142-horse power, and are arranged in pairs, each arm of the building containing one pair placed parallel to each other lengthwise of the arms, having the fly-wheels at the entrance end, and the cylinders at the inner end of the arm, so that the eight steam cylinders are arranged symmetrically round the centre of the building under the dome. The diameter of steam cylinder is 4 feet 6 inches, and the length of stroke 9 feet; the diameter of the sewage pumps, of which there are two to each engine, being 3 feet 10½ inches, and their stroke 4 feet 6 inches. The maximum quantity of sewage and rainfall which it is estimated these engines will have to lift is 15,000 cubic feet per minute. The sewage is brought into the pump well, which forms the lowest storey of the building, from the low level sewer, but, before admission, is strained of any extraneous matters which may be brought down with it, and which would either not pass or be detrimental to the pump valves, by means of cages of wrought-iron bars, which are placed in chambers in front of the engine-house, and which are capable of being lifted and emptied when full. The building containing the machinery and appliances for this purpose stands in front of the centre of the engine-house, and from the chambers beneath it are three sewers conveying the sewage, after being strained, to the pump wells in three of the arms of the engine-house. From the sewage well the water is lifted through rectangular cast-iron pipes, situate at the sides of the building, into the sewage pumps, and it is from them forced through cast-iron cylinders 6 feet in diameter, running along the centres of three of the arms of the building, and below the engine-room floor into an air vessel in the centre of the building, whence the sewage lifted by the six engines is forced through a similar cast-iron cylinder 10 feet in diameter, carried along the centre of the fourth arm of the building, and into which the sewage from the pumps situate in this arm is also discharged, the whole being forced through a cast-iron cylinder 10 feet 6 inches in diameter, carried from the engine-house through the yard into the outfall sewer, arrangements being made at its junction therewith for regulating the discharge. The reservoir for the storage and purification of the water for the use of the boilers and for condensing purposes is situate on the opposite side of the embankment of the northern outfall sewer. It is constructed mainly of concrete, is 18½ feet in depth, and covers an area of about one acre, which is divided into three compartments, each compartment being used in turn as a settling pond, and containing about one million gallons.

It would be too much to suppose that one out of twenty of the visitors to the pumping-station yesterday was capable of appreciating the marvellous mechanical contrivances that he saw in operation; but they witnessed enough to impress them with a deep sense of the rare ability and skill with which Mr. Bazalgette and his assistants have accomplished the task set before them. The least instructed among us cannot but remember that, as the engineer-in-chief modestly states, the waters of the Thames during the present summer, though one of unprecedented heat and drought, have been entirely free from smell, and its banks from those accumulations of sewage deposit which formerly rendered them so offensive and dangerous. This great result is patent to us all; and the elaborate machinery by which it is accomplished impresses the mind with a sense of deep wonder and admiration. You stand in the centre of the building, around you eight huge beams are working up and down, eight immense wheels revolving round and round. Day and night the incessant work proceeds; and every minute ten, or it may be fifteen thousand cubic feet of London rainfall and sewage is being lifted.

The inspection of the machinery was followed by a luncheon, in a tent that had been raised for the occasion. Sir J. Thwaites was in the chair. The repast, liberally furnished by the Board of Works, having been done full justice to, some toasts suitable to the occasion followed. "The Health of the Chairman" was proposed by Lord J. Manners. Lord Ebury's name was associated with the toast of "The House of Lords," and Lord J. Manners with that of "The House of Commons." Mr. Bazalgette had his health very cordially drunk, and Mr. Tite also had to acknowledge a similar compliment.—*Standard.*

Manufactures.

British Factories.—According to the latest official return (1862), there were in the United Kingdom 6,378 textile factories, of which 5,652 were situated in England and Wales, 568 in Scotland, and 158 in Ireland. There were in these factories 36,450,000 spindles, 490,866 power looms, 230,546 power loom weavers, and 2,163 gigs; the total amount of power being 375,292 horses steam and 29,339 water. The hands employed in these were 775,534, of whom 467,261 were females. The different factories were thus distributed:—

	England and Wales.	Scotland.	Ireland.
Cotton	2,715	163	9
Woollen	1,456	184	39
Worsted	512	17	3
Flax	136	163	100
Hemp	3	2	—
Jute	4	27	5
Hosiery	65	4	—
Silk	761	8	2
Total	5,652	568	158

Commerce.

Coal Production of Calais.—From 1851 to the end of 1866, 10,000,000 tons have been obtained from these mines; 6,500,000 tons have been raised since 1862, in which year the communication was completed with the canals and lines of railways in the north of France, In 1866, the total quantity obtained was 1,621,400 tons, or about one-seventh of the total produce of France. Each of the five mines of Lens, Counières, Noeux, Grenay, and Dourgis (the oldest), contributes about 100,000 tons annually; Lens in particular nearly 400,000 tons. These five give two-thirds of the whole produce of the district. The remaining twelve mines are of modern date, and are less favourably situated with respect to canal or railway communication. As regards the quality of this coal, it is certainly more suited to manufactories than to household purposes. Nevertheless it furnishes seven-tenths of the total consumption of coal in the department, which is about 925,000 tons. Independently of a population of 750,000, the numerous manufactories in this part of France have naturally benefited largely from the proximity of these coal fields. These manufactories consist of 76 sugar mills, 22 distilleries, 18 silk and flax mills, &c. The price of this coal, even in the neighbourhood of the pits, is maintained at from 18 to 20 francs per ton, a high price considering what is paid in England in similar localities. This, however, is explained by the fact that there is no fear of competition with the English coal, the price of which would be nearly, if not quite, double that of the French coal in the neighbourhood of Douai, &c.

Export of Yeast.—Although we receive a good deal of dried yeast from Hamburg and other quarters, there is a large demand for English yeast in France. Last year it was shipped chiefly by way of Calais, instead of by Boulogne and Dunkerque as hitherto. This yeast is forwarded to the distilleries of Lille, Seclin, Dondi, and Valenciennes. It appears that French yeast is much inferior to the English, and in addition is double the price. When we consider that there are upwards of 38,000 brewers in the United Kingdom, the trade in yeast must form an important item of home consumption.

Colonies.

Melbourne Agricultural Statistics.—The wheat crop last year was 3,489,893 bushels, a decrease of 1,151,312 bushels on the yield of the previous year, and affording little more than five bushels per head to our population, while the decrease in the oat crop was not far short of 60,000 tons. Only 41,355 acres additional were brought under tillage in 1867, against 84,799 acres in the previous year.

Preserved Meat.—A tank of meat preserved by the Victorian Company has been examined. It has been lying in store at Melbourne for about three months, and was about being shipped to England. The tank contained about two tons of mutton. The carcases of the sheep had been boned, slightly salted and spiced, rolled in linen cloths, and then packed in the tank. The meat was thoroughly tested, and pronounced to be in excellent order, and a most marketable article. The portions of the carcases prepared in this way were cut through and tasted, and the flavour was delicious. It is said that meat thus cured can be landed in London markets at such a price as to give the shopkeepers a fair profit if retailed at 5d. per lb.

Woollen Manufacture.—The first auction sale in the colony of Victoria of locally-made woollen cloth took place a day or two ago, at Geelong, when 7,400 yards of cloth made at the Geelong Woollen Company's works were offered for competition. There was a large attendance of the trade from Melbourne, Geelong, and Ballarat. There were altogether 315 lots offered for sale. The bidding was spirited, and as much as 16s. a yard was realized for some lots. The prices ranged from 5s. 3d. to 9s. for single widths, and from 13s. to 16s. for six quarters. This is a great deal higher than the English cost, or probably than the cloth is intrinsically worth. The quality and material are said to be very fair and creditable for a first production. Altogether nearly £3,000 was realised.

Publications Issued.

Dessins Originaux des Grands Maitres. Photographs by M. Adolphe Braun, of Dornach, Haut Rhin. A highly-interesting portfolio of photographic reproductions in pigment printing of designs by the old masters, belonging to the various museums in Europe. The work includes nine hundred designs from the Louvre, eleven hundred pieces from the Albertine of Vienna, one hundred and fifty pages from the collection of the Grand Duke of Saxe Weimar, and several hundred drawings from the little-known Uffizi Collection, at Florence. M. Braun has lately produced, at Milan, copies of the Ambrosienne entire, with the eighty drawings by Leonardo de Vinci, and the cartoon of Raphael's "School of Athens;" at Venice he has reproduced more than three hundred of the designs in the Academy of the Beaux Arts; at Florence he has photographed the most remarkable examples of sculpture, ancient and modern. M. Braun announces that he intends shortly to explore the artistic treasures of England.

Artistes et Rapins. By Louis Leroy, Le Chevelier, Paris. An amusing satire on the peculiarities of the world of art, by a clever writer.

Forthcoming Publications.

Dictionnaire Général des Artistes de l'Ecole Française depuis l'origine des arts du dessin jusqu'à l'année 1868 inclusivement (architectes, peintres, sculpteurs, graveurs et lithographes). Par Emile Bellier de la Chavignerie. A work just announced to appear, from the pen of a practised critic. Every French artist whose works have been three times admitted by an exhibition jury, is admitted into the dictionary, and the principal critics and writers on art are also included.

Notes.

Chinese Museum.—A large number of Chinese works and curiosities have been imported into France of late years, and the Louvre now includes a Chinese museum; an immense number of specimens are also distributed over the various palaces; and it is said that the Empress has determined to have them all collected at Fontainebleau, where a Chinese museum already exists.

Passenger Traffic with France.—The passenger traffic at Calais in 1867, as might have been expected from the circumstance of the Paris Exhibition, was greater than in any previous year, reaching nearly 200,000 persons, against 125,532 in 1866. It is, however, worthy of remark that whereas in 1862, the year of the London Exhibition, 30,586 more passengers passed through Boulogne than through Calais, in 1867 about 47,000 more passengers passed by Calais than by Boulogne. The number of passengers who passed through the other parts in 1867 was, Boulogne, 153,000; Dieppe, 88,000; and Havre, 16,177.

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 28th July*, 1868.

367. East India (Rangoon and Western China)—Despatch.
443. Tea Licenses—Return.
451. Foreign Cattle—Return.
Post-office—Thirteenth Report of the Postmaster-General.

Delivered on 29th July, 1868.

254. Bill—Public Schools (Lords Amendments).
255. „ Sale of Poisons and Pharmacy Act Amendment (Lords Reason for disagreeing to one of the Amendments made by the Commons).
454. Natal—Judgments.
Railways (Ireland)—Sections, &c.
Fisheries (Ireland)—Report of Special Commissioners.
Treaty of Navigation (England and Austria).

Patents.

From Commissioners of Patents' Journal, July 31.

Grants of Provisional Protection.

Advertising apparatus, &c.—1008—H. A. Bonneville.
Anchors, fishing—2191—F. R. A. Glover.
Boilers, &c., joints in—2181—W. R. Oswald.
Bookbinding apparatus—2217—J. Cope and J. Bradbrook.
Book slides—2209—G., G. W., and J. Betjemann.
Caps or bonnets—2197—R. Mackie.
Carriages—2092—J. Randall and W. R. Crabb.
Cartridge shells and heads—2062—A. H. Brandon.
Chaff-cutters—2165—J. Prest, W. Mather, and W. Doherty.
Chimney tops and ventilators—2149—J. Thomson.
Drawings in crayon, &c., fixing on paper—2171—E. Rouget.
Driving bands, &c.—2167—A. J. Le Blanc.
Fabrics, &c., bleaching—2214—J. Bastow.
Feathers, artificial flowers, &c., ornamenting—2161—C. D. Abel.
Fire-arms—2169—T. Kerr.
Fire-arms, breech-loading—2222—W. Payton.
Fish slices, &c.—2215—E. F. Kittoe.
Forts, &c., constructing—2155—T. R. Crampton.
Furnace bars, moving—2226—H. Lawrence.
Gas tubing, &c., india-rubber—2159—T. J. Mayall.
Hemp, &c., spinning—2064—A. H. Brandon.
India-rubber, gutta-percha, &c.—2175—T. J. Mayall.
Iron floors and ceilings, filling the spaces between the beams of—2188—G. Davies.
Iron, &c.—2207—A. Munro and W. B. Adamson.
Lamps—2232—J. H. Johnson.
Locks—2199—C. E. Brooman.
Looms—2183—A. M. Clark.
Looms—2242—J. C. Ramsden.
Mills for grinding bones, &c.—2216—J. Booth.
Phosphates of lime, treating—2157—A. P. Price.
Photography—2201—E. Edwards.
Presses for the expression of oil, &c.—2234—T. Cook.
Pumps, &c.—2195—J. S. Nibbs.
Railway carriages, &c.—2218—T. Wood.
Railway rails, old, utilising—2187—C. E. Brooman.
Salts of ammonia—2136—A. McNeil and W. Wheaton.
Ships, propelling—2213—J. and J. M. H. Taylor.
Shirt fronts—2236—J. L. Macfarlane.
Studs and buttons—2189—J. Jefferys.
Sulphate of lead—2116—J. B. Gregson.
Wool, &c., dyeing—2203—W. J. Hanson.

Inventions with Complete Specifications Filed.

Glue—2368—W. R. Lake.
Zinc, separating from the argentiferous alloys obtained in the separation of silver from argentiferous lead by means of zinc—2340—C. D. Abel.

Patents Sealed.

314. C. Riley.
355. D. Murray.
360. J. and W. Weems.
362. J. Combe and J. Barbour.
363. J. M. Domenech and F. P. Jonte.
366. C. Richardson.
372. R. A. Jones.
387. T. W. Walker.
407. J. T. White.
463. G. Seamer.
578. L. M. Becker.
600. S. Firth.
603. R. Heathfield.
646. J. Perrett.
1293. W. Gorse.
1767. H. Haines.

From Commissioners of Patents' Journal, August 4.

Patents Sealed.

390. R. J. Jones.
392. M. P. W. Boulton.
398. J. Hay.
401. A. E. Borgen.
410. C. Brakell.
411. W. Tongue.
419. W. Hann.
427. P. Rothwell.
431. W. Richardson.
433. J. Key and E. Hoskins.
476. R. C. Ross.
505. J. S. Raworth.
532. J. and J. Hinks.
533. A. M. Clark.
582. M. A. F. Mennons.
686. C. Sanderson.
829. J. Wallis.
959. E. D. Johnson.
973. S. Holmes.
1229. A. and L. Braham.
1793. W. R. Lake.
1827. D. Foster.
1943. W. R. Lake.

Patents on which the Stamp Duty of £50 has been paid.

1964. E. Sabel.
1962. F. A. Abel.
1977. J. Lawson and E. G. Fitton.
1980. A. V. Newton.
2138. G. Howard.
2034. H. C. Baudet.

Patent on which the Stamp Duty of £100 has been Paid.

1884. C. E. Amos and J. Francis.